the sources to which an author attaches most weight, and here Mr. Hetherington proves himself at once catholic and discriminating. The older European authorities like Dr. Bushell, Sir A. Wollaston Franks, and his successors in the famous school of the British Museum have naturally been used to great advantage, while the writings of Mr. Berthold Laufer and other special workers in the history of early Chinese art have been drawn upon with discrimination. One would say off-hand that no modern opinion of value has been overlooked, while each, in turn, is supported or refuted from authoritative sources. This piece of patient toil has been carried out with much discrimination, as is especially manifest in the author's appraisement of the information that is to be obtained only from Chinese sources. The valuable original sources are set out in a select bibliography, where a list of the most important English and French works on the subject is also given.

The illustrations of the ancient wares, gathered from many sources, are worthy of the book and really illustrate it, while they have been chosen in a truly commendable way. Mr. Hetherington explains the manner of his choice in a few words which deserve to be quoted: "In selecting the illustrations I have followed a somewhat unusual course. The specimens chosen are not the rarest and most costly examples, nor are they taken from the great National Museums. I have illustrated typical pieces of good quality in the possession of private collectors. The ordinary person, in my opinion, wants to see the kind of thing he may hope to acquire for himself; not specimens worth a king's ransom which are never likely to adorn his cabinet."

WILLIAM BURTON.

Optical Theories.

(1) *Die Prinzipien der physikalischen Optik. Historisch und erkenntnispsychologisch entwickelt.* Von Ernst Mach. Pp. x+444. (Leipzig: J. A. Barth, 1921.) 48 marks.

(2) *Optical Theories: Based on Lectures delivered before the Calcutta University.* By Prof. D. N. Mallik. Second edition, revised. Pp. vii+202. (Cambridge: At the University Press, 1921.) 16*s.* net.

(1) ERNST MACH died in February 1917, at a time when civilised humanity was too busy to notice the passing of one who had made his influence felt wherever interest existed for the understanding of the fundamentals of mechanical and physical knowledge. The present work was published in 1921, but it is not a posthumous work, for it was ready before the war, and in fact the preface is dated July 1913. Although it went to press in 1916, the war and other causes delayed its issue.

As the title indicates, the book is an historical and epistemological account of the development of the principles of physical optics, the writer's aim being similar to that in his famous book on Mechanics. The book is thus not really a history, but rather a statement of the progress of ideas and of the manner in which they arose in the minds of their originators. Nobody who has read other books by Mach will need to be told that this volume is interesting and instructive: the description of the way in which the fundamental notions such as periodicity and asymmetry of the light ray emerged, is as fascinating as any romance.

The present volume was intended as a first part of a larger work: subjects like theories of the ether and relativity were reserved for the second volume. But the author's foreboding that this second volume would not be written by himself was unhappily justified.

Many points of interest emerge in the course of this history. Full tribute is paid to Newton's genius—it was Newton who first realised clearly the periodic nature of the light ray, later worked up into the wave theory, and its asymmetry, which became the theory of polarisation and the notion of the transverse light-vector. When Fresnel first reached the conclusion that light oscillations are transverse, the revolution in ideas was too great for even Arago, who refused to be associated with Fresnel's idea, and in fact, although Fresnel and Arago collaborated in many pieces of work, the transverse vibration theory was put forward in a paper bearing only Fresnel's name. Young's experiments did not at once receive the recognition they deserved, owing to the mistaken and reactionary servitude to all that was supposed to have emanated from Newton. The author has not much good to say about Schopenhauer's attempt at a theory of colours, while faint praise is all that is allotted to Goethe.

As already remarked, relativity as such is not discussed in this book, and even when Michelson's interferometer is described nothing is said about the 1887 experiment. Nevertheless the author felt it incumbent upon him to decline the honour of having been the herald (*Wegbereiter*) of relativity. On various grounds he refuses to accept the theory—presumably this refers to the restricted theory—and, while acknowledging the value of the relativist researches, he doubts whether the theory itself will find a lasting place in the physical *Weltbild* of the future. Mach asks: "Will the theory of relativity be more than an ingenious *aperçu* in the history of this science?" Would Mach's opinion have been affected by the events of 1919?

(2) The lectures delivered by Prof. Mallik at Calcutta in 1912 were published in book form in 1917, and the

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book has been reissued in a second edition. It offers a brief technical *résumé* of the optical theories since Descartes and Fermat till the present day, a little being also said about ancient European and Indian ideas on the subject. The elastic solid theories, the electromagnetic theory, and the electron theory are passed in review, each treated briefly in mathematical manner, with its virtues and its imperfections exposed. In the second edition there are a few additions, notably on the theory of relativity in so far as it affects optics, and the opinion is expressed that this theory will not " dispose of the physical existence of the *etherial model*, until a better one can be found, which shall explain the intimate nature of the various concepts of modern physics, corpuscles and negative particles, electric charge and magnetic force, gross matter and gravitation, in one comprehensive scheme."

S. BRODETSKY.

Notes on Inorganic Chemistry.

Notes on Inorganic Chemistry for First Year University Students. By Prof. F. Francis. Pp. viii + 244. (Bristol: J. W. Arrowsmith, Ltd.; London: Simpkin, Marshall and Co., Ltd., 1921.) 8*s*. 6*d*. net.

THE reputation which Prof. Francis has gained as a teacher is so firmly established that a book written by him on the lines that he has adopted for his lectures may be expected to be of much interest and value. Although the " Notes " have been written primarily for students of Bristol University they will, no doubt, be found useful by many others.

The book commences with a few interesting extracts of a philosophical nature from the works of various authors and a brief note on the indestructibility of matter; the subject of errors is then fully discussed, and the laws relating to gases are considered at length. The properties of hydrogen and oxygen are next described together with those methods of preparation which are of practical or theoretical importance. Opportunity is thus afforded for reference to catalysis, autoxidation, and the methods of determining the relative atomic weights of these two elements. The next three chapters are devoted to a discussion of the chemical atom, energy, thermochemistry, and to a fuller account of catalysis. In the chapters on the physical properties of water, a variety of subjects are discussed, such as vapour pressures and boiling points, the phase rule, solutions, osmotic pressure, electrolysis, dissociation, and the electron theory. The utilisation of atmospheric nitrogen in the preparation of ammonia and nitric acid is considered in some detail and the natural sources of these substances are mentioned. Reference to the action of sulphuretted hydrogen on arsenious acid serves as an introduction to a brief discussion of the chemistry of colloids, and in the remaining chapters Dulong and Petit's law, the periodic law, the laws of constant composition and of multiple proportions, the law of isomorphism, and the subject of valency are discussed.

The book is for the most part very clearly written, but typographical errors are rather numerous: for example (p. 9), $3{\cdot}1415^{10}=93{,}621$, not 93·621; (p. 21) ρ' should read ρ; (p. 36) for Nitrogemn read Nitrogen; (p. 44) Lavoisier's name appears in place of Scheele's; (p. 56) for " proportional now " read " proportional. Now "; (p. 97) ·62%, etc., should be 62%, etc.; (p. 110) for Ladenberg read Ladenburg; (p. 179) for $HClO_4$ read $HClO_3$; (p. 205) the formulæ for apatite and vanadinite require correction; (p. 207) in the italicised sentence, " of " should read " or " and " methods " should read " molecule "; (p. 226) the constant *m* does not appear in the formula.

No doubt these mistakes will be corrected when a second edition is required.

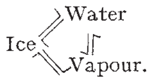
There are a few statements which appear to be open to objection: On p. 23 Dalton's law of Partial Pressures is stated thus: " If P = total pressure and V = total volume,

$$\begin{aligned} P &= p_1 + p_2 + p_3 \ldots \\ V &= v_1 + v_2 + v_3 \ldots \text{”} \end{aligned}$$

It is not stated, however, that the second equality only holds if the volumes are all calculated at pressure P.

In the thermochemical equations on p. 57 it would perhaps be better to write $\frac{1}{2}H_2$ rather than H where molecular and not atomic hydrogen is meant.

On p. 65 there is the statement that " at 0° C. and 4 mm. pressure, Ice$\rightleftharpoons$Water$\leftarrow$Vapour." Presumably " $\rightleftharpoons$Vapour " is intended, but, in any case, the triple point pressure of water is 4·6 mm., and at 0° C. and 4 mm. pressure water could only exist as vapour. A correct statement would be: " at 0·0075° and 4·6 mm. pressure



It is stated on p. 88 that " one gm. molecular weight of Methyl Alcohol, 32·03 gms., dissolved in 1000 gm. of water raises the Boiling Point to 100°·52 "; but, of course, all mixtures of methyl alcohol and water boil at a lower temperature than pure water. It is evidently assumed that methyl alcohol is practically non-volatile.

The following sentence occurs on p. 204: " atomic weight of Sulphur: atomic weight of Selenium = 18·39 : 45·34 of Sulphur = 32." Presumably the words " of Sulphur = 32 " should be deleted. There is also a

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